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METHOD FOR LAYING PIPELINES WITH THE USE OF A ROTATING RAMP
[Verfahren zum Verlegen von Rohrleitungen mittels einer Drehrampe]

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The invention concerns a method and a device for laying pipelines, and to be sure down onto the ocean floor from a floating watercraft. In particular, the invention concerns a procedure for laying pipelines, in which the angle at which the pipeline enters the water is adjustable, and to be sure by the use of a rotating ramp. /1*

It has been usual up until now to employ a rotatable lifting ramp mounted on a floating pipeline-laying ship for controlling the pipe /2 contour and pipe loading when laying a pipeline, in order thereby to support an overhanging part of the pipeline hanging down from the laying ship. It has been found that the length of the supporting ramp needed to provide appropriate support for controlling the pipe contour can be rather large with increasing water depth. The supporting ramp, with this increased length, can have greater sensitivity to the stress imposed by the supported pipeline or by ocean conditions.

In conjunction with proposed methods for laying pipelines it is agreed that in some cases it is possible to do without the supporting ramp, and to be sure by the selection of the pipe contour and the pipeline loading by control of the angle, and to be sure with regard to the horizontal pipe as well as that left behind from the ship. The desired angle of penetration for a given, desired contour can be changed according to numerous conditions, such as, for example, the pipeline weight and stress limit, the rate at which the ship moves and the water depth. In addition to that, the required angle can change /3 under certain laying conditions according to the selected cross-sectional contour of the pipeline, which can have the form of a chainlike beam capable of bending, that of a beam under tension or a different form, such as the one proposed by Lawrence in US patent document 3,472,034, which was transferred to the legal successor of the present invention.

Known methods for laying pipelines, such as that disclosed by Lawrence in US patent document 3,472,034 and the procedures from US patent documents no. 3,26?,23? and no. 3,38?,563 [illegible numbers], had as their objective the changing of the pipeline-penetration angle by utilizing a pipeline that has an take-up frame with a pivotable mounting on a ship. A current approach is likewise described on pages 32 to 54 of the [illegible] edition of the publication *Ocean Industry*, Volume 5, No. 3, 1970, from the Gulf Publishing Company, in which there is an evaluation of a swinging ramp employed for laying a beamlike pipeline with bending capability.

Although this method can be quite acceptable, certain difficulties can be anticipated with its use, particularly when supplying additional pipe sections to and from the take-up frame. Moreover, these procedures are largely limited in their ability to change the angle of penetration. /4

*Number in the margin indicates pagination in the foreign text.

Because laying operations in relatively shallow water require a smaller penetration angle due to pipeline characteristics, such as size and weight, in order to retain the desired pipe contour, while other laying operations require a large penetration angle of 60^{o} or more, those methods mentioned thus far are limited in their applicability.

It is therefore a principal goal of the invention to create a method for laying pipelines, in which the penetration angle of the pipeline can be controlled by the use of a rotating-ramp frame or uptake frame mounted on a floating ship and in which operational difficulties arising with the supplying of additional pipeline sections are kept to a minimum.

A further objective of the invention is to create a method for /5
pipeline laying, in which the penetration angle of the pipeline can be adjusted over a wide range.

A further objective is the creation of such a method for laying pipe, in which a rotating ramp frame or take-up frame is used, and which is in harmony with the operation of continuous methods for feeding new pipe sections.

Another task of the invention, associated with the above, is to create such a method for laying pipe, in which a rotating ramp or uptake frame is used, which is in harmony with the operation of nonintermittent procedures relative to the supplying of new pipe sections.

A preferred embodiment form, satisfying at least some of the indicated requirements, includes a laying ship equipped with a slot at the rear of the ship. An elongated, essentially rigid ramp for taking up the pipe, capable of rotating, is mounted at the rear of the /6
ship near this slot. The ramp is able to pivot at one point between its ends and able to turn optionally between an essentially horizontal position and an angle as large as 80^{o} relative to the horizontal. First and second gripping elements are installed on the ramp. One gripping element is essentially attached to the ramp and utilized for holding the pipeline essentially immobile relative to the ship during those procedures associated with the addition of new pipeline sections. The other gripping element is movably attached to the ramp and transmits tension to the pipeline during the laying down of the pipe.

An element for feeding pipe parts is positioned with preferably the same axis of rotation as the ramp. This feed frame is provided with an element for attachment to the same around the feed frame, the pipe section being brought onto the feed frame when the latter assumes a generally horizontal position. In the preferred embodiment form, /7

the feed frame is installed in such a way that it can be moved into various positions, in which the support for the pipe section on the feed frame and the pipe-supporting elements associated with the ramp frame are aligned in essentially one plane and in the longitudinal direction. Once the feed frame has been rotated into this position, the new pipe section is aligned in a work station and welded to the existing pipeline.

A work-station platform is rotatably mounted on the ramp for this purpose in a manner that permits it to swing unhindered in order thereby to remain essentially horizontal during each position of the ramp.

After conveying the pipe section to the ramp frame, the loading system can return to its horizontal position to take up a new piece of pipe, while the stepwise laying/rolling-out process of pipeline-laying, which moves the welded joint to the next work station, is being carried out. As a result, a further piece of pipeline is laid, the total quantity of the same being essentially equal to that /8
quantity corresponding to the newly added pipeline section. At this point the feed system is rotated upward in order thereby to produce a new section of pipeline for welding.

In this way it is possible to implement a method for continual laying, which proceeds without being restricted by the advance of new pipeline sections with the aid of the feed frames. In addition to that, the described preferred embodiment form of the invention is able to regulate the pipeline-penetration angle over a wide range.

Examples of embodiment forms of the invention are illustrated in the drawings. Appearing there are:

Fig. 1 a longitudinal cross section of a pipeline-laying ship equipped with gripping elements and an element for laying pipeline sections according to the invention;

Fig. 2 a top view of the structure seen in Fig. 1, the feed frame having been omitted for clarity;

Fig. 3 a top view of the structure seen in Fig. 1, in which the /9
ramp frame and its associated structure have been omitted for clarity;

Fig. 4 a cross section along line 4-4 in Fig. 1, with the rotating attachment the ramp and feed frame to the ship;

Fig. 5 a cross section along line 5-5 in Fig. 1, with the pipe-positioning clamps on the ramp frame;

Fig. 6 a cross section along line 6-6 in Fig. 1, with the pipe-section holders on the feed frame;

Fig. 7 a cross section along line 7-7 in Fig. 1, with the location of a gripping element on the feed frame;

Fig. 8 a partially sectioned side view along line 8-8 in Fig. 9, along the stationary gripping element on the ramp frame;

Fig. 9 a partially sectioned end view of the gripping system seen in Fig. 8, along line 9-9 of the same;

Fig. 10 a cross section along line 10-10 in Fig. 1, with a part of the pipe-leading section of the ramp frame;

Fig. 11 an enlarged cross section along line 11-11 in Fig. 1, of the displaced device and a holder system for keeping the guide pipe of the inner attachment element immobile on the ramp frame; and

Fig. 12a;
Fig. 12b;
Fig. 12c; and
Fig. 12d are schematic, transverse side views with a pipe-laying process according to the invention.

Figures 1 to 3 show a type of basic structure employed in the /10 pipe-laying process according to the invention.

Figure 1 shows a pipe-laying ship **20**, floating on the water **22**. The ship **20** is provided at the stern with a slot **24** that extends into the water **22**.

Mounted adjacent to the slot **24** is an elongated, essentially rigid ramp frame **28** that turns on a horizontal axis **26** (Fig. 2). This ramp frame can be moved selectively between a generally horizontal position and rotated positions, which can assume an angle as large as 80° relative to the horizontal.

The ramp frame **28** can have a towerlike form that consists of three sections: a pipeline-leading section **30** that extends outward away from the stern of the ship **20**, an intermediate working zone and gripping section **32**, and a pipeline take-up and feeding section **34** that extends up to the bow of the ship.

Provided in the pipeline-leading section **30** is a plurality of pipeline-guiding element that is shown schematically at **36** in Figs. 1 and 2 (and omitted from the other figures for the sake of /11

simplicity). The guiding elements **36**, described below in detail, prevent a pipeline leaving the ramp frame from having less than a predetermined radius of inclination over the entire length of the pipe-leading section **30**. In general, the angle at which the pipeline leaves the leading section **30** can be between 5^{o} and 7^{o} of the intended direction, without the pipeline being exposed to excessive stress.

The working zone of the gripping section **32** of the ramp frame **28** is provided with a gripping element **38**, adjacent to the guiding element **30**, which is essentially fixed relative to the ramp frame **28**. This gripping element **38**, which is described in greater detail below, is optionally employed in such a way that a pipeline can hold a pipeline essentially immobile with regard to the ramp frame **28** and therefore fixed relative to the ship **20**. At two work platforms, **40** and **42**, are likewise installed in the intermediate ramp section **32**.

The platform **42** positioned closest to the ship's bow /12 functions as a support for those workers busy with the attachment of new pipe sections to the end of the piece of pipeline previously laid. This station **42** called a welding station below for the sake of simplicity, although other attachment procedures can be carried out there. The other work platform **40** serves to provide a place from which the pipe joint can be inspected or pipe welding with an overlay can take place. As described below, platforms **40** and **42** can be adjusted, so that they will remain in a horizontal position throughout all the rotating movements of the ramp frame **28**.

That section **34** of the ramp frame **28** for the take-up and feeding of the pipeline is provided with pipe sections positioned at intervals in the longitudinal direction, which actuate gripping jaws **44**.

The gripping jaws **44** (Fig. 2) consist of opposing mirror-image structures related to the same, of gripping sections [illegible], which are arranged at intervals in a take-up space **48**, on opposite /13 sides of a pipe section. As described below, the gripping jaws **44** operate in such a way that align a pipe section axially at the end of a previously laid pipeline held in the leading section **30** and intermediate section **32** of the ramp frame **28**. They likewise move the end of the pipe section into the desired spacing relationship, maintaining the desired welding gap as a result.

It is evident from Fig. 2 that section **34** of the ramp frame **28** for the take-up and feeding of the pipeline supports a monorail track **50** that extends in the longitudinal direction over the space **48** taking up the pipe section. As described in greater detail below, the monorail track **50** supports a gripper housing **52** serving for the movement of the ramp frame **28**. The gripper housing **52** is a generally cylindrical, bell-shaped hollow part that has an open end **54** toward

the stern of the ship and, toward the bow, an essentially closed end **56**.

The essentially closed end **56** has an opening sufficiently /14
large to receive a tensioning cable **58** and hydraulic hub **60**, wound around guide rollers **62** and **64**, which are in turn arranged on opposite sides of the bow end of the ramp frame **28**. The cable **58** and hub **60** are controlled by remote-controlled winch regulators **66** (only one of which is shown), which are mounted on the ramp frame **28**.

Inside the gripper housing **52**, the cable **58** and the hub **60** are connected with an internal gripping jaw as seen in Fig. 12, at 266, and as described and claimed in the US patent application by Clyde E. Noland, the latter application, in the Applicant's possession, having been filed for an "inner tensioning system for the laying of pipelines". A description of the internal gripping jaw's method of operation is presented below. Sufficient for now is the indication that the inner gripping jaws serves to grip at least one of the pipelines or newly added pipe sections internally and is tightened /15
by means of a conventional winch controller 66, and that the tensioning cable **58** transfers tension to the pipeline, while the ship **20** moves ahead during a pipeline-laying operation.

Let it be stated at this point that the laying of the pipeline can proceed alternately, and without concern for the movement of the ship, as described in the section having the title: "COMPOSITE MODE OF OPERATION OF WHEEL-TYPE TENSION MECHANISM 18 AND Gripping MECHANISM 1[illeg.] FOR PIPE-FEEDING OPERATION", of US patent document no. 614,558, filed by Jerry J. Jones on April [illeg.] of 1969 for "Method and Apparatus for Laying Pipelines", which is Applicant's property.

An elongated, essentially rigid pipe-section feed frame **68** is rotatably mounted on the ship **20**, preferably for movement around the same axis as the axis of rotation of the ramp frame **28**. The feed frame, in that embodiment form shown, has a towerlike form, that /16
is to say, has the shape of an inverted Z in the starboard elevation (Fig. 1).

The lower section **70** of the feed frame **68** can be taken up in a nonhindering connection directly beneath the working-gripper section **32** of the ramp frame **28**. The upper section **72** of the feed frame **68** can be freely taken up beneath the element **34** for the uptake and feeding of the pipeline.

This upper section **72** of the feed frame **68** is provided, arranged at intervals in the longitudinal direction, with gripping elements **74** (Fig. 3), which will be described in still greater detail, and at the upper part of the same. The gripping elements **74** serve to hold the

pipe section immobile relative to the feed frame **68**, during further feeding of the pipe section to the ramp frame **28** by the feed frame **68**.

These pipe sections are ordinarily supported on a pipe-transfer station **76**, which is mounted on the ship at one position for the ramp frame **28** and the feed frame **68**. In general, a pipe-section conveying system **78** can be arranged in the center of the pipe-transfer station **76**. /17

When the feed frame **68** is in a lower position (i.e., in a generally horizontal position, as seen in the embodiment form), the conveyer system can operate to guide a pipe section **80** to the same. In the lower position, a generally straight load-holding element, bordered by support stations **82** arranged at intervals in the longitudinal direction, is aligned in the longitudinal direction with those holding elements provided by the conveyer **78**.

After receiving a pipe section **80**, the feed frame **68** can be moved into a higher position, in which the load-holding element, bordered by the support stations **82**, is generally in one plane with the pipeline-supporting element of the ramp frame **28**. The pipeline-supporting element of the ramp frame can serve to hold an essentially straight pipeline part, and is bordered by the guide element **36** positioned closest to the ramp frame on the intermediate section **32**, the fixed gripping element **38** on the intermediate section **32** and one or more additional supporting parts (which are essentially identical with the guiding elements **36**), which, if desired, are attached in an appropriate manner in the intermediate section **32** of the ramp frame **84**, as seen of course only in Fig. 1. /18

In the case of the present invention, care should be taken to ensure that the "generally linear arrangement" gives consideration to pipeline changes and the bending resulting during the laying of pipe in conjunction with pipe sections or holding elements used for them.

Due to the holding relationship between the ramp frame **28** and feed frame **68** in the embodiment form shown, the ramp holding element and the load-holding element are mutually aligned, in one plane, in the longitudinal direction. An unhindered advance of a pipe section **80** to the actuating gripping jaws **44** of the ramp frame **28** is therefore made remarkably easier.

It can likewise be stated at this point that such an - in itself amazingly advantageous - connection is not absolutely necessary to draw the greatest possible advantage from this invention. It is however desirable to provide some sort of feed frame, and to be sure with a generally straight section for holding pipe, which can be moved in a single plane with a pipeline-holding element on the ramp frame, preferably via movement through a space that is distant from the /19

pipeline end held by the ramp frame. The simple further conveyance of the pipe section to the ramp frame is made effectively easier in this way, and of course due to the fact that the manipulation of the pipe section is restricted to small displacements in order to align it with the previously laid pipeline. In addition to that, the advance of the pipeline section presents no danger whatsoever to the workers, because the pipe section is moved from a point distant from the pipeline end and therefore distant from the work area. A further advance likewise does not interrupt the progress of the pipeline-laying operation, because the feed frame can turn back without interruption, while the new sections are being joined together and the pipeline laid.

In this conjunction it becomes clear that the invention makes continual pipeline-laying operations possible in the broadest sense, in which the pipe is laid without interruption, while new pipe are /20 being added, as well as operations in which the pipeline is discontinuously held against the relative movement with regard to the floating ship.

An example of a modified form of arrangement possessing the above-named advantages can take the form of a feed frame installed for movement to the side rather than beneath the ramp frame. The feed frame can in this situation be easily equipped with a moveable conveyer mechanism, such as, for example, rotating gripping jaws, in order thereby to move the pipe section to the side of the ramp frame after the loader pipe section has been moved into one plane with a ramp pipeline holder.

It is apparent from Figs. 1 to 3 that, in the embodiment form illustrated, the leading section **30** of the ramp frame **28** is covered by a platform **86** that is, in turn, anchored by holding frames **88** on opposite sides of the slot **24** in the ship. Fig. 3 shows a part of the frame **80**.

A winch **90** can be provided on the platform **80**. This winch /21 controls the inclination of the ramp frame **28**, and to be sure by attachment of a cable **92** that passes through an opening in the platform (not shown) and is connected in a suitable manner to the leading section **30** of the ramp frame **28**. The leading section **30** can have a balanced weight, so that it will be able, as a result, to rotate the ramp frame **28** (and to be sure in the clockwise direction, as seen in Fig. 1) on the axis of rotation **26**.

In the uppermost position of the cable **92**, the ramp frame **28** is held in an essentially horizontal position with the pipeline uptake and feeding section **34**, which reposes on the upper part **94** of a support tower **96** installed in a fixed position on one side of the ship **20**. The selected laying of the cable **92** and also the balanced leading section **30** have made it possible to load the ramp frame **28** in selected, fixed positions. The slot **24** in the stern of the ship

receives the leading section of the ramp frame **28**, particularly when the angle of the ramp frame becomes large relative to the horizontal.

Regulation of the position of the feed frame **68** is made easier /22 by means of the winch **98**, which is mounted in a suitable manner on the upper part of the feeding and uptake section **34** of the ramp frame **28**. The winch **98** controls a cable **100** that is moved through the section **48** taking up the pipe and connected by any suitable means to the feed frame **68**. This connection is naturally such that inference with the pipe section **80**, brought onto the feed frame **68** by the conveyer **78**, is avoided.

In its lower position, the feed frame **68** can, if desired, rest on a lateral extension of the tower **96**. When the ramp frame **28** is initially rotated upward, the loading-element control winch **98**, so that the feed frame can remain in its lower position. After a pipe section **80** has been introduced into the feed frame **68**, the winch **98** is actuated to retrieve its cable **100** in order, as a result, to turn the feed frame **68** upward into its preselected, immobile rotated position. If desired, a suitable holding part (not shown) can be provided on the ramp frame **28** in order to prevent overtravel of the ramp frame **28**. The winch **98** can also be however be situated in such a way that the /23 feed frame will be brought into the correct position automatically, the cable **100** being in its fully retracted position.

The structural features of the ramp part **28** and of the feed frame **68** are illustrated in Figs. 4 - 11 as an example of an acceptable form of the basic parts utilized in the pipe-laying system according to the invention.

The leading section **30** of the ramp frame **28** can be formed from interconnected, essentially cubical frame sections. The description of the components takes place with reference to the ramp frame **28** situated in the horizontal position. Each cubical frame section can have longitudinally extending, parallel, horizontal beams **102** and **104**, which are arranged at a distance from one another as lower and upper beams, two transversely extending, parallel upper and lower horizontal beams **106** and **108**, arranged at a distance from one another, two diagonally extending, parallel struts **112** joining together the upper and lower beams **102** and **104** and parallel, vertical struts **110**, and diagonally extending horizontal beams **114** that interconnect beams /24 extending in the longitudinal direction and in the transverse direction (Figs. 1, 2 and 10). Formed in this way is a stable, rigid, cubical network that borders a central ramp opening **116** (Fig. 10) for the uptake of a pipe section and is not hindered by the towerlike elements of the ramp frame **28**.

As seen in Fig. 10, the guiding elements **36** of the leading section **30** are mounted on the lower, transversely extending beam **108**.

Additional guiding elements **36** can be installed on the upper beam **106** and the vertical struts **110**. The guiding elements **36** can consist of conventional holding rollers **118** that have axes of rotation on both ends. The guide rollers can, if desired, be vertically adjustable. From Fig. 1 it is evident that the remote elements **36** mounted at the bow of the ship are installed, one after the other, in positions located more radially outward in order to limit a predetermined inclination radius of the pipeline thereby held.

The element group **36** in the leading section **30** can be /25
designated for simplicity as a group forming a "guide socket". If desired, steel rings or other elements can be provided in the leading section **30** as a "guide socket". Due to the arrangement of the guide socket in the shape of a ring, whether via rollers or rings, the pipeline can be advantageously conveyed in all directions. Although the pipeline is normally not in engagement with the guide socket, this guide makes it possible to regulate the pipeline's angle of inclination and permits the advance of the pipeline from the ramp frame **28** in order thereby to achieve the predetermined angle.

The intermediate section of the 32 of the ramp frame **28** likewise consists of frame sections limited in a manner similar to that of the pipeline-leading section **30**. These sections are not explained in detail, because the structural differences will be immediately evident to the specialist.

From Figs. 1 to 4 it is evident that a gripping-holder platform
120 is located within the struts, directly above and on opposite /26
sides of the axis of rotation **26**. The platform includes the rotation axis and extends laterally out over the strut network, and of course likewise over attachment elements **122** mounted on opposite sides of the slot **24**, and is thereby rigidly attached to the ship **20**.

The platform **120** is rigid and attached in a suitable manner to the strut elements. Located on opposite sides of the platform **120**, and attached to the same, are mounting flanges **124** that extend downward. The flanges rotatably supported on pivot pins **126**, extending through the same, and are supported by attachment elements **122**. The pivot pins **126** are adjacent to the rotation axis of the ramp frame **28**.

Located between outer sides of the platform **120** are inwardly projecting attachment flanges **128** that define openings **130** axially aligned with the axis of rotation **26**. These openings receive pivot pins **132** on which arms **134**, attached at intervals, are rotatably mounted. The arms **134** attached in a suitable manner with the end-frame parts **136** and form the end parts of the feed frame **68**. The
loading element **68** is thus likewise mounted so that it can turn, /27
rotating on the axis **26**.

Although one specific pivot mounting for the rotation of the ramp frame **28** and of the feed frame **68** on the axis **26** has been described, it is obvious that many other arrangements are likewise possible.

It can also again be confirmed, by referring to Fig. 4, that the central ramp opening **116** is likewise present in the intermediate section **32** of the ramp frame over the platform **120**. The previously explained gripping element **38** is mounted on the platform **120** in such a way that the axis **138** defined by the gripping sections of the same, which will be described below, coincides with the axis of the pipeline passing through the central ramp opening **116**.

The platform **120** can likewise serve to support one or more of the previously described holding elements **84**, which can be identical with the one or more roller supports **36** of the leading section **30**. In addition to that, because the bottom, horizontal and transverse strut elements **108** (as described below in conjunction with the leading /28 section 30) are continued from the intermediate ramp section 32 to prevent an interference between the ramp frame **28** and the feed frame **68**, the platform **120** also being employed to support the initial holding elements **36** of the guide socket. This attachment is not shown however in Fig. 4.

It should be noted at this point that, although the platform **120** includes the frame sections of the intermediate ramp section **32**, and to be sure in that region provided for the gripping element **38**, they are thereby divided, as shown at 140 in Fig. 2, in order thereby to permit an upward movement of the previously described work station **40**.

From Figs. 1 and 2 it is evident that means for the automatic elevation of the work stations **40** and **42** are provided, due to the fact that horizontal supporting arms **142** are installed on the strut parts on the starboard and port sides of the intermediate ramp section **32**. The supporting arms **142** anchor pivot pins **144** by which the platforms /29 **146** are supported in a freely swinging manner.

The generally horizontal axis defined by the pivot pins **144** and the unhindered swinging movement of the platforms **146** ensures that the station platforms will remain horizontal in all rotated positions of the ramp frame **28**. If desired, elements (not shown) can be used to anchor the platforms **146** in this horizontal position, once the platforms **146** of the work stations have been horizontally aligned with the ramp frame **28** in a rotated position. As seen at **148** in Fig. 2, the platform is forked in order thereby to prevent interference with the pipeline (see Fig. 12) passing through the central opening **116** of the ramp frame.

Let reference now be made specifically to Figs. 5, 6 and 7, in which the structural components of the pipe-guiding and laying section **34** of the ramp frame is likewise described along with the main part of the feed frame **68**. As indicated in these drawings, the pipeline take-up and feeding section **34** of the ramp frame **28** includes connected /30
frame sections **150** and **152** on the port and starboard sides, which are mounted on opposite sides of the previously described uptake space **48** for the pipe section.

The frame sections **150** and **152** are essentially identical, though they are smaller than the frame sections forming the leading section **30** of the ramp frame **28**, and to be sure with the supplementary vertical, inclined struts **154**, which extend diagonally between the upper and lower strut parts. It is moreover clear that the frame sections **150** and **152** are interconnected mirror images and are joined by transversely extending, horizontal girders **156** that span the space for receiving the pipe sections. The stiffeners **156** support the monorail track **50**, on which the housing **52** for the internal gripping jaw is supported and slides.

From Fig. 2, it is evident that suitable transition frame sections are provided, as indicated at **158**, to connect the frame sections **150** and **152** of the pipe take-up and feeding section **34** with /31
the frame sections of the intermediate ramp section **32**.

Figure 3 and Figs. 5 - 7 show that the upper section **72** of the feed frame **68** is formed from interconnected frame sections **160**, which are essentially identical to the frame sections **150** and **152** of the pipeline take-up and feeding section **34** of the ramp frame **28**. The lower section **70** of the feed frame **68** is similarly arranged and connected in a suitable manner with the upper section **72**.

From Fig. 6, it is evident that the upper frame parts of the supporting frame sections **160** provide support for the upper support stations **82**, which together define a generally straight supporting element. The support stations **82** can be essentially identical to the guide rollers **36** described in conjunction with Fig. 10. Moreover, corresponding means are provided, that permit the supporting stations **82** to be moved likewise into a vertical position.

Figure 5 is a cross section of the gripping sections **46** of the /32
pipe-handling grippers **44**, which is mounted on the pipeline take-up and feeding section **34** of the ramp frame **28**. The gripping sections **46** are arranged in a mirror relationship on opposite sides of the uptake space **48** for the pipe section. Each gripping section **46** can be installed on the lower and upper horizontal girders **162**, which are suitably attached to the mutually opposing parts of the frame sections. The attachment of the gripping sections **46** on the supporting girders **162** is such that the gripping sections **46** can move

along the girder length. By means of this attachment, a pipe section held by the gripping elements **44** can be moved from this position to the welding station **42**.

The gripping sections **46** are all provided with concave, resiliently mounted jaws **164**. Figure 5 shows the gripping elements open in order to seize a pipe section (not shown). The axis **138**, defined by the concave gripping elements **164**, coincides with the axis of the pipe section held. Suitable elements, such as hydraulic pistons that are shown schematically at **165**, can be provided to move /33
the gripping elements toward or away from the pipe section. If desired, means can be provided for the vertical movement of the gripper-support girder **162** to compensate slight alignment changes in the axis of the pipe section held.

Figure 7 is a schematic cross section of gripping jaws **74** fixed to the feed frame **68**. The gripping jaws are mounted on the upper parts of the feed-frame sections **160**. In the position shown, the fixed gripping jaws **74** border an axis **138** that coincides with the axis through the gripping elements **164** of the gripping jaws **44**. It is therefore apparent that the fixed jaws **74** on the feed frame **68** are essentially identical to one another, except for the means of attachment to the mobile gripping jaws **44** on the ramp frame **28**. The attachment thereby makes provision for a later vertical adjustment of the sections in a suitable manner.

As seen in Fig. 8, the gripping system **38** exhibits a gripping arrangement **166**, which is installed for a restricted movement, /34
barely detectable by the eye, in a direction indicating a load, and extends in the longitudinal direction of the pipeline **168** held on the ramp frame **28**. The gripping arrangement **166** is connected to a loading system **169** via connecting linkage that transmits a force. The loading system **169** is anchored to the supporting platform **120** behind device 166. The loading system can for example be of the hydraulic type, such as the load transmitter manufactured by the Decker-Martin Corp. in Long Beach, California, model number CC-1000-50. It is obvious, however, that other pneumatic, hydraulic, electrical or mechanical load-handling systems can be employed.

The gripping system **166** can be articulated in the general manner described by Report 66-2 of the Gray Tool Co., Post Office Box 2291, Houston, Texas.

The arrangement seen in Fig. 8, the loading system **169** should have a housing fixed to the platform **120**. The housing should /35
enclose a loading system, and to be sure, one of that type described above, which is generally situated in the longitudinal direction, in force-receiving alignment with the power-transmitting part **170**. The loading system can be inserted between the force-transmitting part **170**

and the housing for the loading system, and of course in the conventional manner.

With this arrangement, force is generally transmitted to the loading system **169** in the longitudinal direction of the arrangement **166**, part **170** acting as a consolidating, force-transmitting part. Moreover, the loading system **169** can be mounted on the forward part of the system **166**, the loading system being arranged in such a way that part **170** acts as a force-transmitting part that operates under stress.

As illustrated in Figs. 8 and 9, the gripping system **166** has laterally divided frames **172** and **174** facing the stern and the bow. Three curved pipe-gripping jaws, **176**, **178** and **180**, are supported by these frames **172** and **174** and positioned between them in the longitudinal direction.

The uppermost section **176** is connected by supporting elements /36
182 to removably installed pins **184** and **186**. The pins, **184** and **186**, are installed on opposite sides of each divided frame **172** and **174**.

Each attachment pin **184** and **186** is located in a vertically elongated slot and therefore has limited movement in the vertical direction. Attachment pin **184** is thus arranged in slots **188** and **190** on the starboard side of the frames **172** and **174**. Pin **186** is installed in a mirror arrangement in slots on the port side of the frames **172** and **174**.

The holding arms, **192** and **194**, serve for a rotatable suspension of the upper ends of the jaw segments, **178** or **180**, on the attachment pins **184** and **186**, which is illustrated in general in Figs. 8 and 9.

As seen in Fig. 9, forked arms, **196** and **198**, extend downward from the lower free ends of the gripping segments **178** or **180**.

The screw block **200** is mounted between the arms **196** for a /37
rotating movement around a horizontal axis extending parallel to the vertical middle plane of the pipeline **168**, on axes of rotation **202** and **204**. Axis **202** extends toward the rear and though a control slot in frame unit **172**. Axis **204** extends in the forward direction and is supported in frame unit **174**. The control slots, **206** and **108**, are parallel and mirror images of one another.

A threaded adjustment spindle **210** has a threaded portion **212** that extends through a tapped hole **214** in the screw block **200**. The adjustment spindle **210** extends from an electric or hydraulic motor **216** mounted in the frame unit **174**.

As seen in Fig. 9, the threaded spindle **210** is likewise provided with a threaded part **218**, passing through the screw block **220**, which

is carried on the arm **198**. The screw block **220** has a shaft **222** supported in control slot **224**. Screw block **220** - like screw block **200** - is situated for rotating movement on a horizontal axis extending essentially parallel to the vertical center plane of the pipeline **168**. /38

The screw block **220**, slot **224** and shaft **222** are identical, but are a mirror image of those components described in conjunction with block **200**. The threaded parts **212** and **218** of the spindle **210** are however cut in opposite directions and correspondingly arranged to interact with screw blocks **200** or **220**. With this arrangement, the rotation of the spindle **210**, produced by the movement of the motor **216** connected to the spindle as a drive, will move the blocks **200** or **220** toward one another or apart, independently of the rotation direction of the spindle.

When rotation of the spindle **210** moves the blocks apart, the shape of the control slot changes as a result of the separation of segments **178** and **180** produced by the rotation, and the axes of rotation **184** and **186** are likewise moved upward. This upward movement is made possible by the vertical slot, which are arranged in a mirror image of one another and receive the pins **184** and **186**.

The separation of the blocks **200** and **220** thus force each of the segments **176**, **178** and **180** to move outward, thereby releasing the outer periphery of the pipeline as a result of this separation. There is consequently no friction or pulling action between the pipeline and any gripper segment, when the arrangement **166** is in its nongripping state. /39

Moving the blocks **200** and **220** together leads inversely, in a similar manner, to a state in which segments **176**, **178** and **180** exert a gripping effect upon the exterior of the pipeline part.

Segments **176**, **178** and **180** can be provided with surfaces **226**, **228** or **230** that are generally cylindrical. These surfaces are parts of cylinder jackets and coaxially aligned with regard to the outer surface of the pipeline when lying against the same.

The pipeline-support surfaces **226**, **228** and **230** can be removably attached to the gripping segments **176**, **178** or **180**. Furthermore, each of the pipeline-supporting surfaces can exhibit a partially elastic character.

It was furthermore found to be particularly favorable to have the capability of selecting support surfaces **226**, **228** and **230** with different sizes to permit the accommodation of pipelines having different diameters. /40

The frame units **172** and **174** can be constructed on a base **232**. This base **232** can take the form of an efficient and conventional support. Thus, as seen in Figs. 8 and 9, the base **232** can consist of plates, **234** and **236**, arranged one above the other, which are joined together by a plurality of vertical supports **238** that can be extended and retracted. The operation of these supports can be under mechanical, electrical or fluid control. Whenever the various supports operate simultaneously, a raising of the upper base can be adjustably set for efficient support of the gripper segments **176**, **178** and **180**, which is achieved by upward movement.

Such a lifting device serves to adjust the height of the frame units **172** and **174** in order to produce a coaxial engagement of the gripper segments on the pipeline, whenever it is a matter of pipelines with different diameters. It is necessary to mention that /41 pipelines with different diameters also require different height levels for the frame unit and different radii for the pipeline-support surfaces **226**, **228** and **230** to ensure in addition a coaxial supporting effect upon the periphery of the pipeline, when the pipeline part is held by the gripping mechanism **166**.

A vertical movement of the gripping jaws **74** and of the previously mentioned gripper-support girder **162** (which in turn attaches the gripping jaws **44** to the ramp section **34**).

To ensure an unhindered transition of the force between the floating ship **28** and arrangement **166**, so that the load controller **167**, when employed, will indicate the exact tension exerted on the pipeline by the arrangement **166**, the base **236** of the unit can be mounted on one or more rails. These rail sections extend along the pipeline **168**. As seen in Fig. 9, such rails **240** can be attached to the ship **120** in the intermediate ramp section **32**.

In special cases it is desirable to pass a part of the /42 pipeline through arrangement **166** with a T-fitting or with other projecting parts. The passage of such a projecting part through the arrangement can be achieved, for example, by withdrawing the pin to produce an opening in the region between the divided port and starboard ends of the frame unit **172** and **174**.

As seen in Fig. 8, the pin **184** can be removably secured by the tapered guide pins **242** and **244** held in the vertical slots **188** or **190**. As a result of telescopic separation of pin 184 from pins **242** and **244**, segment **176** is free and can rotate in the counterclockwise direction, as seen in Fig. 9. A similar structure can be provided with pin **186**.

The removal of pin **184** can be made easier by an arrangement in which this pin is axially divided, but joined together by threaded components.

It must still be mentioned that the operation of the mechanism **166** can further provide a broad range of possibilities for modification of the gripping and load-indicating devices, to include arrangements of that device described in US patent document 3,390,532. In this conjunction it should be stated that arrangement **166** must be viewed as a platform by which the upper portion of the pipeline **168** is gripped, this platform being movable and capable of an apparently undetectable change to reproduce the necessary expansion during the change of forces acting upon the pipeline in this gripping direction. /43

It must likewise be understood that, when reference is made to the anchoring or securing of pipelines against an essentially relative movement of the floating ship, this condition provides an adjustment to the pipeline movement produced - but not limited to - wave action, which is explained Lawrence's patent mentioned above.

Within the large range for changing the gripping devices, it is for example possible to employ a vertical counteracting gripper instead of the rotating gripping elements seen in Figs. 8 and 9. It can likewise be mentioned that fluid-driven gripping elements of the Packer type can be used, such as those contemplated for example in US patent document 3,273,347, filed by Delaruelle et al. Furthermore, a fixed external gripping system in US patent document 3,491,541, filed by Berard, can be employed. /44

The arrangement of a movable, external gripping jaw, similar to the one in this specification, can likewise be utilized in place of the internal gripping jaw **266** (Fig. 12).

Fig. 11 presents a cross section with a part of an element for regulating the position of the internal-gripper housing **52**. As already mentioned, the housing **52** is able to move in the longitudinal direction of the pipeline-uptake and feed section **34** of the ramp frame **28**. This movement is made easier by a monorail **50**. The housing **52** is thus attached in a suitable, fixed manner by supporting arms **246**. /45

Each supporting arm hangs down from a roller system **248** that glides on a monorail track **50**. The support **248** can consist generally of L-shaped support arms **250**. The support arms are situated in a mirror image and joined together in any suitable manner beneath the monorail track, as illustrated in general terms at **252**. Situated toward the inside, opposite the support arms **250** and rotatably positioned on the same, are pins **254**, on which wheels **256** are arranged. The wheels **256** run in the pathways defined by the generally I-shaped monorail track **50**.

Due to the fact that, as previously mentioned, the rear portion 56 of the internal-gripper housing **52** is essentially closed, the

gripper housing **52** can be left in the relative position on the ramp element **28**, as seen in Figs. 1 and 2, whatever the inclination of the ramp housing **28**, and to be sure only by actuation of the crank element **66** in order thereby to retract the attached internal gripping jaw. This procedure also works to pull the housing **52** back as well, and /46
to be sure by the interaction between the internal gripping jaws against the essentially closed rear portion **56** of this housing.

As it will be described in still greater detail below, the housing **52** can, due to the movement of the supports **248** on the monorail track **50**, assume a position, and to be sure as a result of the inclination of the ramp frame **28**, which is bordered by the welding station **42** and thus lies at the pipeline end laid in this position. As it will be described, the internal gripping jaw will at this moment be in a position situated at a distance from the gripper housing **52** in the longitudinal direction. Once the internal gripping jaw is back in the housing **52**, it can then be necessary to create a stop element to leave the housing **52** immobile, in order to prevent interference between the retracted gripping jaws and the housing, so that the housing will not be displaced by the internal gripping jaw during the movement upward on the monorail track **50**.

An acceptable form of such a stop element is shown in Fig. 11, /47
this structure not being illustrated in Figs. 1 and 2 for the sake of simplicity. The stop element **258** shown can consist of such a magnetic brake that is not in contact, as well as of a core **260**, wound with a coil **262**. If excitation takes place, a magnetic field will then arise, which provides resistance due to the conductivity of the wheels 256. The core **260** can be attached to the upper frame parts **263**, near the end of the monorail track **50**. Suitable electrical connections can be provided to permit remote control of the brake **258**. Once the internal gripping jaw is again in the housing **52**, the brake **258** is naturally de-energized. It is of course desirable, when the ramp frame is in its horizontal position, to provide suitable means to turn the gripper housing **52**.

A method according to the invention for laying a pipeline is illustrated in Figs. 12a, 12b, 12c and 12d.

First of all, the desired angle for penetration of the pipeline /48
into the water is set. The ramp frame **28** is then swung on an axis of rotation **26** into a fixed position in which the longitudinal direction of the length of the ramp frame **28** defines an angle, and to be sure with reference to a horizontal plane, which is essentially equal to the desired angle of penetration. In other words, this means that the central axis of the central ramp opening **116** (Fig. 4) will define an angle in which the horizontal plane is equal to the penetration angle.

As already known, the movement of the ramp frame **28** into its chosen rotated position takes place by means of a counterweighted leading section **30**, controlled by a winch **90** and a cable **92**.

It can now be assumed that the essentially straight portion of the pipeline **168** is anchored by a ramp-supporting element, and to be sure at an angle equal to the selected angle of penetration, the rest of the pipeline extending into the water **22**. The manner in which /49 the laying of the pipe is initiated in order to achieve this support will be clear to the specialist from the remainder of the illustration. It should merely be emphasized at this point that the fixed gripping element **38** is actuated to leave the pipeline **168** essentially immobile relative to the ramp frame, and therefore likewise to the ship.

Prior to the addition of the new pipe sections **80** to the pipeline **168**, the actuating gripping jaws **44** are withdrawn into a position very distant from the end of the pipeline **168**, as indicated by the arrows **264**. This pipeline end is positioned above the welding station **42**.

A section of pipe **80** is fed to the load-supporting element **82** by the conveyer **78**, and to be sure with the feed frame in its lowered, horizontal position, as shown in Fig. 12a, due to the extension of the cable **100** under the control of the winch **98**. The load-gripping elements **74** are then actuated to leave the pipe section immobile /50 relative to the feed frame **68**.

It should be noted that the schematically indicated internal gripping jaw was retracted into the gripper housing during the receiving of the pipe section **80** on the feed frame **68**, and to be sure with the aid of the winch **66**. In addition to that, the internal gripping jaw **266** and the housing **52** have been retracted into their most distant position on the monorail track **50**, that is to say, into that position bordering the upper end of the ramp frame.

As seen in Fig. 12b, the next step is to rotate the feed frame **68** on the rotation axis **26** into an immobile position in which the longitudinal direction of the feed frame **68** and the supported pipe section **80** define an angle with regard to the horizontal plane, which is essentially equal to the angle of penetration. In the preferred embodiment form, this operation is carried out by the winch **98** that controls the cable **100** in order to raise the feed frame into a position in which the pipe section **80** has been taken up inside that part **48** (Fig. 2) of the ramp frame that receives the pipe. In /51 this position, the pipe section **80** is in general in one plane with the straight part and, coaxially aligned with the same, with the pipe section held by the ramp frame **28**. Stated in different terms, this means that the aligned pipe section **80** is arranged by the end **54** between the planes positioned at intervals in the vertical direction,

as well as the internal gripper housing **52** and the generally straight portion of the pipeline supported on the ramp frame **28**.

The pipe section **80** is brought to the ramp element **28** by the operation of the position gripping jaws **44** and the disengagement of the load-gripping jaws **74**.

At this point, the feed frame **68** is returned to its generally horizontal position, as seen in Fig. 12c. /52

Figure 12b shows that the winch **66** operates in such a way that the internal gripping-jaw element **266** is able to glide out of its housing, into the new pipe section **80**. If the new pipe section assumes a position on the ramp frame **28** such that the upper part of the same is arranged at a distance from the housing **52** in the longitudinal direction, the housing **52** will then be able, due to the inclination of the ramp **28**, to glide down the monorail track **50** until it is adjacent to the bell-shaped end **54** of the same at the end of the pipe section **80**.

To make a relative movement of the internal gripping element **266** from its housing **52** and into the pipe section **80** easier, the internal gripping element **266** can be equipped with hoisting elements (not shown). This hoisting element can be remote-controlled, and to be sure in order to turn the inner tool, via the previously described hub **60**, in situations in which the inclination of the ramp element **28** is not sufficient for gravity to effect a movement of the internal gripping element **266**.

Figure 12c shows that, while the feed frame is being brought back to receive a new pipe section, the actuating gripping jaws **44** on the ramp frame **28** move the pipe section thus gripped into a position in which a suitable welding gap will be formed between the pipeline **168** and the pipe section **80**. Such a movement of the gripping jaws is indicated by the arrow **268**. As a result, the housing **52** of the internal gripping element **266** can move along the monorail track **50**, and to be sure in contiguous connection to the upper end of the pipe section **80**. /53

Prior to the movement of the pipe section **80** by the actuating grippers **44**, the internal gripping elements **266** can be released. The actuation/releasing of the internal gripping element **266** by the hydraulic hub **60** is sufficient to ensure that the gripping elements carried by the internal gripping jaw **266** will move outside the gripping jaw in a radial direction, and with a firm grip upon the internal part of the pipe section **80**. In this way, the pipe section **80** and the internal gripping element **266** are left in a fixed position relative to one another. As determined in the previously mentioned /54

patent application by Noland, which was filed on the same day as this application, the internal gripping element **266** can likewise be attached to the pipeline **168** and serve for the alignment of the pipe section **80**.

Once the pipe section **80** and the pipeline **168** reach their final position over the welding station **42**, those workers on the platform of this station can join the two parts together. After the welding operation has been completed, the ship **20** can be moved forward, i.e., away from that part of the pipeline already laid, as indicated by the arrow **270** in Fig. 12d, in order to move the newly produced joint over the second work station **40** as the first step in laying the pipeline. During this laying operation, the firmly attached gripping element **38** on the ramp frame **28** is released from the pipeline **168**. In addition to that, the internal gripping jaw **266**, as already mentioned, is supported on the pipe section **80** or on the pipeline **168**. During the laying operation, tension is applied to the internal gripping element **266** and therefore to the pipeline **168** via the winch **66** and its associated cable **58**.

The pipeline can be provided with a coating at the second work station **40**. The pipeline is then laid over the remaining distance, and to be sure in such a way that the end of the same is brought over the welding station, as illustrated in Fig. 12a. /55

The feed frame **68** is supplied with an additional pipe section **80** during the joining and laying operation, and those steps mentioned in conjunction with Figs. 12a to 12d are repeated.

It is clear to specialists that suitable control elements can be provided to release the gripping elements **38**, **266** and **74** of the ramp frame **28** and the feed frame **68** by remote control, and likewise for remote control of the actuating grippers **44** and winches **66** and **98**. It is obvious, moreover, that elements can be provided for the remote control of elements that leave the internal-gripper housing **52** in an immobile position, while the internal gripping jaw is being retracted into the housing, and to be sure prior to the movement of the gripping jaw **266** and of the housing into that position seen in Fig. 12a.

By means of the present invention, a method for laying pipe could be created, in which the angle at which the pipeline penetrates the water can be controlled with the aid of a rotating ramp. /56

Of particular importance there is the fact that a feed element is present, which makes a continuous process for laying pipe easier, and by which operating difficulties during the conveyance of additional pipe sections from and to the ramp frame are avoided.

Particularly advantageous in this conjunction is the certain movement of the feed frame, by which the pipe sections are brought from the feed frame to the ramp frame, without thereby causing disturbances at the work stations.

An associated advantage consists of the use of movable internal-gripping elements, the gripping elements, which could be disruptive in the work areas, not being exposed as a result.

Further remarkable advantages reside in the fact that feed frame is taken up in the ramp frame in the case of the preferred embodiment.

It is moreover significant that freely swinging work stations /57 are present, which remain essentially horizontal, whatever the rotated position of the ramp frame. The guide socket has the additional advantage that it guides the pipeline in all directions.

Of independent significance is the fact that the ramp frame can be employed in various laying operations, particularly when large differences in the penetration angle of the pipeline are to be feared. The ramp frame can thus be left in its horizontal position, even during a pipeline-laying operation, in conjunction with the use of a lifting ramp that is rotatably attached to the ship.

Although the invention has been described in conjunction with reference to a specific system, it will be obvious to the specialist that additions, modifications, substitutions or omissions can be made to this system, without in any way restricting the scope of the invention.

P A T E N T C L A I M S /58

1. Device for laying a pipeline, and to be sure into the water from a floating ship, which has elements for the gliding support of a pipeline part on the ship, the remainder of the pipeline hanging down into the water, as well as elements that add pipe sections to the pipeline and elements for controlling the laying of the pipeline under tension, **characterized by the fact** that the element for the support of a pipeline part consists of an elongated ramp frame (28) with ramp-supporting elements (36, 38, 84) arranged at intervals, which border a pipeline support for holding a section of the pipeline (168) on the ship (20), the remainder of the pipeline hanging down into the water, and of elements for the attachment and movement of the ramp (90, 92, 122, 124, 126), providing a rotatable attachment of the ramp /59 elements (28) and permitting movement of the same into selected, fixed positions that are inclined relative to the floating ship, and that the elements for feeding pipe sections consist of a longitudinal, essentially rigid feed frame (68) with load-supporting elements (74, 82) for the support of a pipe section (80) to be added to the pipeline (168), and elements for the attachment and movement of loads (98, 100,

128, 130, 132, 134) in order to attach the feed frame (68) to the ship, and to be sure for a movement between a lower pipe-uptake position and upper positions selected with the load-supporting elements (72, 84), in which case these elements operate to support the pipe section (80) with an angle of inclination relative to the floating ship (20), which is essentially equal to the angle of the ramp frame, and where elements (38, 50, 52, 58, 66, 266) for control of the laying of the pipeline are attached to the rotatable ramp /60
frame (28), at least partly under tension.

2. Device according to Claim 1, characterized by the fact that the elongated ramp frame (28) is mounted essentially rigidly and rotatably at a point (26) between the ends (30, 34) of the same, and that the feed frame (68) is rotatably attached to pivot into selected upper positions, in which the load-supporting elements (72, 84) and the ramp-supporting elements (36, 38, 84) lie essentially in a single plane.

3. Device according to Claim 2, characterized by the fact that the feed frame (68) and the ramp frame (28) are installed to pivot on the same axis (26), and that the ramp frame (28) is equipped with elements (34, 48) to move the feed frame (68) into general alignment with the ramp-supporting elements (36, 38, 84) and the load-supporting elements (72, 84) in the longitudinal direction.

4. Device according to Claim 2, characterized by the fact /61
that those elements (50, 52, 58, 66, 266) attached to the ramp frame (28), which serve to control the laying of the pipeline under tension, exhibit:

a fist gripping element (38) attached to the ramp frame (28) in order to support the pipeline (168) in a selected immobile position relative to the ramp frame,

a second gripping element (266), mounted on the ramp frame (28) for longitudinal movement along the same, which engages in the pipeline (168) and is consequently attached to the same, and elements (58, 66) that, with this, brake the longitudinal movement of the second gripping element (266).

5. Device according to Claim 4, characterized by the fact that the feed frame (68) and the ramp frame (28) are mounted to rotate on the same axis (26), and that the ramp frame (28) is provided with /62
elements (34, 48) for taking up the feed frame (68) with the ramp-supporting elements (36, 38, 84) and the load-supporting elements (72, 84) in general, longitudinal alignment.

6. Device according to Claim 1, characterized by the fact that the elongated ramp frame (28) is essentially rigidly and rotatably attached in order to pivot on an essentially horizontal axis (26), and

to be sure for a movement between an essentially horizontal and an essentially vertical direction.

7. Device according to Claim 6, characterized by the fact that the rotatable ramp frame (28) consists of at least one work platform (146) and elements (142, 144), which support at least one work-station platform (146) on the ramp frame (28) in such a way that it will remain horizontal in all positions of the ramp frame (28).

8. Device according to Claim 6, characterized by the fact that the ramp frame (28) is equipped with elements (34, 48) for moving the feed frame (68) into essentially longitudinal alignment via the ramp-supporting elements (36, 38, 84) and the load-supporting elements /63 (74, 82).

9. Device according to Claim 2, characterized by the fact that the ramp frame (28) consists of elongated guide-socket elements (30, 36) that are installed adjacently to the end portion of the ramp frame (28) to that end of the pipeline (168) thereby held, and that the pipeline (168) is enclosed with these elongated elements (30, 36) to at least 180^{O} in order thereby to control the inclination radius of the pipeline when it is leaving the ramp frame (28).

10. Device according to Claim 1, characterized by the fact that the ramp frame (28) has an element (34) that borders an open feed-ramp take-up zone (48) between one end of the ramp frame (68) and the ramp-supporting elements (36, 38, 84), and

elements for the attachment and movement of loads (98, 100, 128, 130, 132, 134) that include elements (98, 100) for moving the load-supporting elements (74, 82) in the take-up zone, the pipe section /64 (80) being held by the feed frame (68), which in essentially coaxial alignment with the pipeline (168).

11. Process for laying a pipeline in water from a floating ship, and to be sure by means of a gliding support for a pipeline part located on the ship, in which case the remainder of the pipeline hangs down into the water, pipe sections are added to the pipeline and the pipeline is laid under tension, characterized by the fact that a desired penetration angle of the pipeline (168) into the water (22) is established,

an elongated ramp frame (28), rotatably mounted on the floating ship (20), is swung, and the longitudinal direction in the extension of the elongated ramp (28) defines an angle, relative to the ship, which is essentially equal to the desired penetration angle, a part of the pipeline (168) is held in gliding support on the ramp frame /65 (28) and on ramp-supporting elements (36, 38, 84), and to be sure to extend it in the longitudinal direction with the rest of the pipeline (168) hangs down into the water,

a pipe section (80) is supported, which is added to the pipeline (168), and to be sure on supporting elements (74, 82) of an elongated, essentially rigid pipe-section feed element (68), which is movably attached to the floating ship (20) with the feed frame (26) in a low position to receive a pipe section,

the feed frame (68) is moved into a fixed position adjacent to the ramp frame (28), the load-supporting elements (74, 82) supporting the pipe section (80) relative to the floating ship at an angle equal essentially to the angle of penetration,

the pipe section (80) is joined to the pipeline (168),

the feed frame (68) is returned to its lower, receiving /66
position and, finally,

the pipeline (168) is laid in the water (22), and to be sure with a length that corresponds essentially to the length of the attached pipe section (80).

12. Process according to Claim 11, characterized by the fact that the feed frame is moved into a position in which the load-supporting elements (74, 82) and the ramp-supporting elements (36, 38, 84) lie essentially in a single plane.

13. Process according to Claim 12, characterized by the fact that the pipe section (80) is aligned in general with the pipeline (168) by the feed frame (68).

14. Process according to Claim 11, characterized by the fact that the ramp frame (28), in its inclined position, is rotated in an angular direction on an essentially horizontal axis (26), the feed
frame (68) receives the pipe section (80) in an essentially /67
horizontal position, and turns it in the angular direction to the fixed position, and

the feed frame (68) is returned by rotation, in the essentially opposite angular direction, to an essentially horizontal position, in order thereby to receive a further pipe section (80).

15. Process according to Claim 14, characterized by the fact that, first of all, the feed frame (68) is turned in an angular direction opposite to the angular direction, and to be sure before the pipe section (80) is joined to the pipeline (168),and the pipe section (80) is supported on the ramp frame (28) before the feed frame (68) is turned in that direction opposite to the angular direction.

16. Process according to claim 11, characterized by the fact that, during the gliding support of that part of the pipeline (168) on

the ramp frame (28), the pipeline is initially held immobile, and /68
to be sure relative to the ship, the pipeline part being detachably engaged by fixed gripping elements (38) supported by the ramp frame (28) on a lower portion of the same,

that, during the movement of the feed frame (68), the feed frame (68) is brought into an immobile position, the pipe section (80) to be attached to the pipeline being supported in a position in which one end of the same is adjacent to movable gripping elements (266) initially supported by the ramp frame (28) that extends to the upper end of the same,

that, during the laying of the pipeline, the attached pipe section is engaged with movable gripping elements (266), in order thereby to leave the pipeline (168) fixed relative to the same, that the gripping elements (38) are released from engagement with the /69
pipeline (168),

that the hanging pipeline (168) is lowered into the water (22), while tension is maintained on the mobile gripping elements (266), that the pipeline (168) re-engages with the fixed gripping element (38), the mobile gripping elements (266) are disengaged from the attached pipe section (80), and the mobile gripping elements (266) are returned to their starting position, adjacent to the upper end of the ramp frame (28).

17. Process according to Claim 11, characterized by the fact that the ramp frame (28) is in the inclined position, while at least one work-station platform (146) is in an essentially horizontal position and supported between the ends (30, 34) of the ramp frame (28). /70

18. Process according to Claim 16, characterized by the fact that the pipe section (80) is gripped on the feed frame (68), in its lower position, by employing the load-supporting elements (74) in order to leave the pipe-section (80) essentially immobile relative the feed frame (68), and
the pipe section (80) is moved to the ramp element (28), following which the load-gripping element (74) is disengaged.

19. Process according to Claim 11, characterized by the fact that, during the movement of the feed frame (68), the feed frame (68) is raised into a position in which the pipe section (80) held is positioned between vertical planes arranged at intervals, and to be sure by the upper part of the ramp frame (28) and the end part of the pipeline (168) held by the ramp frame (28).

20. Process according to Claim 11, characterized by the fact /71
that the ramp frame (28) and the feed frame (68) are mounted in such a way that they pivot on the same essentially horizontal axis (26).

21. Process according to Claim 11, characterized by the fact that the inclination radius of the pipeline (168) is controlled, while it is leaving the ramp frame (28), the pipeline (168) being enclosed over at least 180^{o} with longitudinal guide-socket elements (30, 36) attached to the end portion of the ramp frame (280, adjacent to that part of the pipeline (168) thereby held.

22. Device for laying a pipeline, and to be sure into the water from a floating ship, which has elements for the gliding support of a pipeline part on the ship, the remainder of the pipeline hanging down into the water, as well as elements that add pipe sections to the pipeline and elements for controlling the laying of the pipeline under tension, characterized by the fact that the element for the support /72
of a pipeline part consists of an elongated ramp frame (28) with ramp-supporting elements (36, 38, 84) arranged at intervals, which border a pipeline support for holding a section of the pipeline (168) on the ship (20), the remainder of the pipeline hanging down into the water, and of

elements for the attachment and movement of the ramp (90, 92, 122, 124, 126), providing a rotatable attachment of the ramp elements and permitting movement of the same into selected, fixed positions that are inclined relative to the floating ship,

elongated guide-socket elements (30, 36) attached to the end portion of the ramp frame (68), adjacent to that part of the pipeline (168) thereby held, and enclose the latter by at least 180 degrees, /73
in order thus to regulate the inclination radius of the pipeline while exiting this ramp frame (28).

23. Device for laying a pipeline, and to be sure into the water from a floating ship, which has elements for the gliding support of a pipeline part on the ship, the remainder of the pipeline hanging down into the water, pipe sections are added to the pipeline and the pipeline is laid under tension, characterized by the fact

that a desired angle for the penetration of the pipeline (168) into the water (22) is established,

that an elongated ramp frame, rotatably attached to the floating ship (20) is pivoted into a fixed angular position, in which the longitudinal direction in extension of the extended ramp (28) defines an angle relative to the ship, which is essentially equal to the desired penetration angle,

and that a part of the pipeline (168) is given gliding support /74
on the ramp frame (28) and the ramp-supporting elements (36, 38, 84), in order thereby to extend essentially in the longitudinal direction, the remainder of the pipeline (168) hanging down into the water (22), and the inclination radius of the pipeline (168) is controlled, while

it is leaving the ramp element (28), by enclosing the pipeline to at least 180 degrees with elongated guide-socket elements (30, 36) installed at the end of the ramp frame (28), adjacent to that part of the pipeline (168) thereby held.

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FIG.1

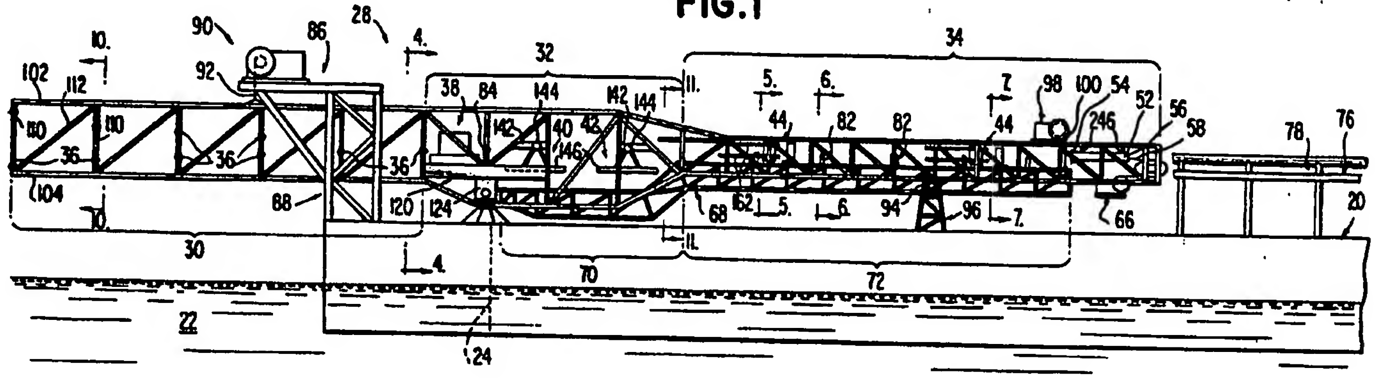
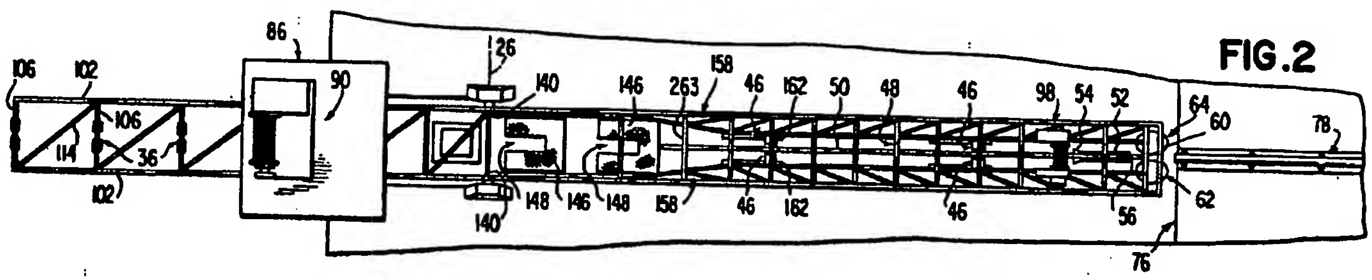


FIG.2



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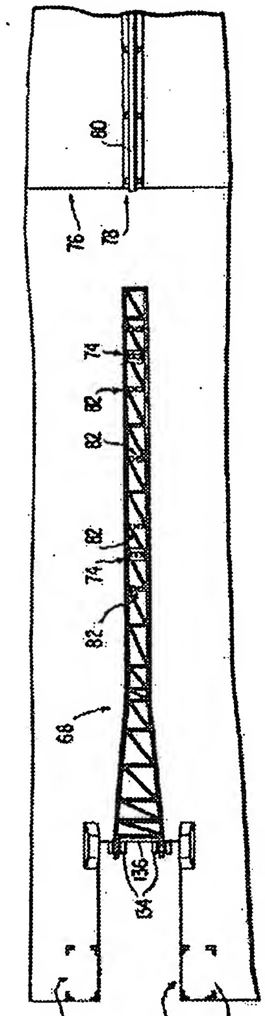

FIG.3

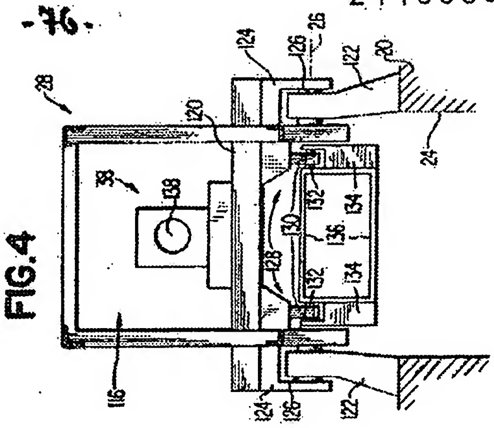

FIG.4

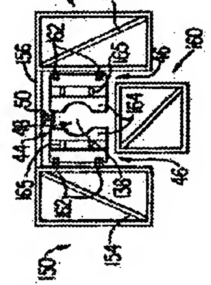

FIG.5

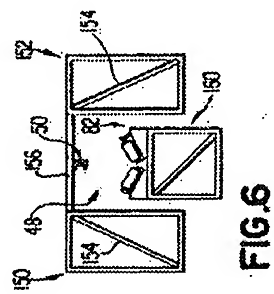

FIG.6

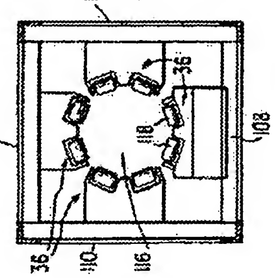

FIG.10

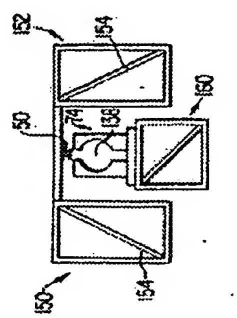

FIG.7

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FIG.9

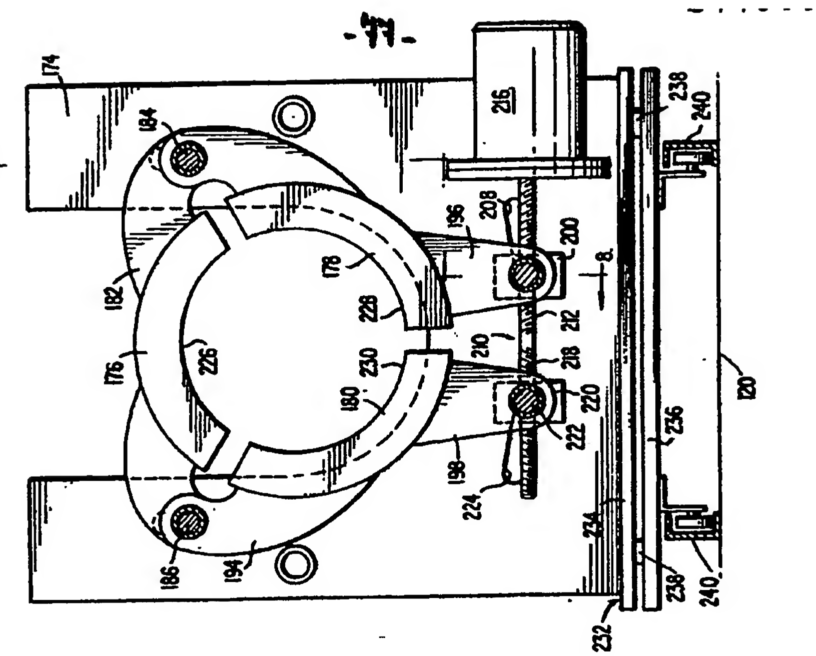
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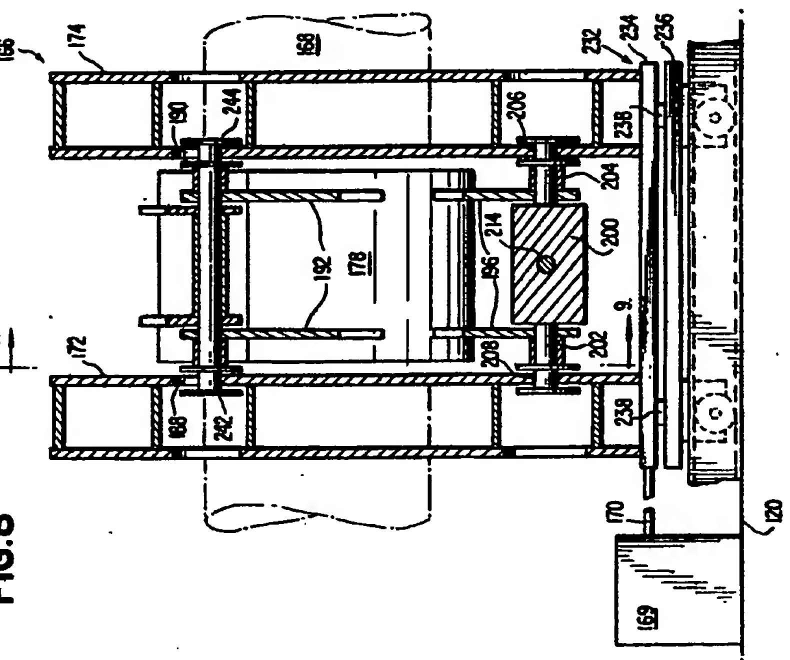
FIG.8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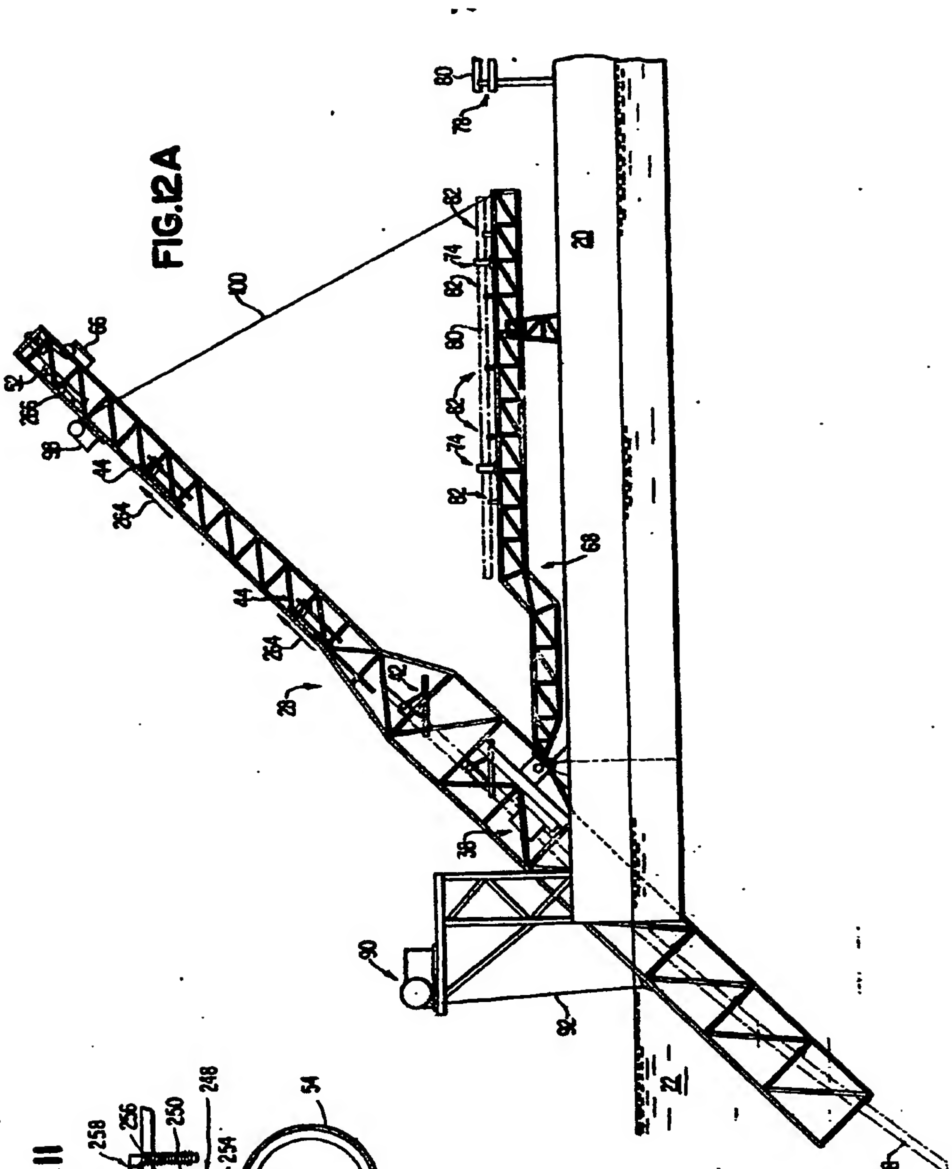


FIG.12A

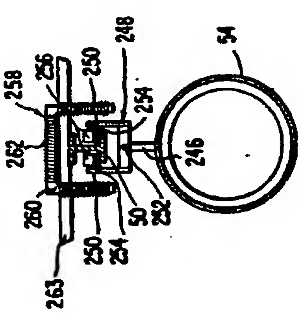
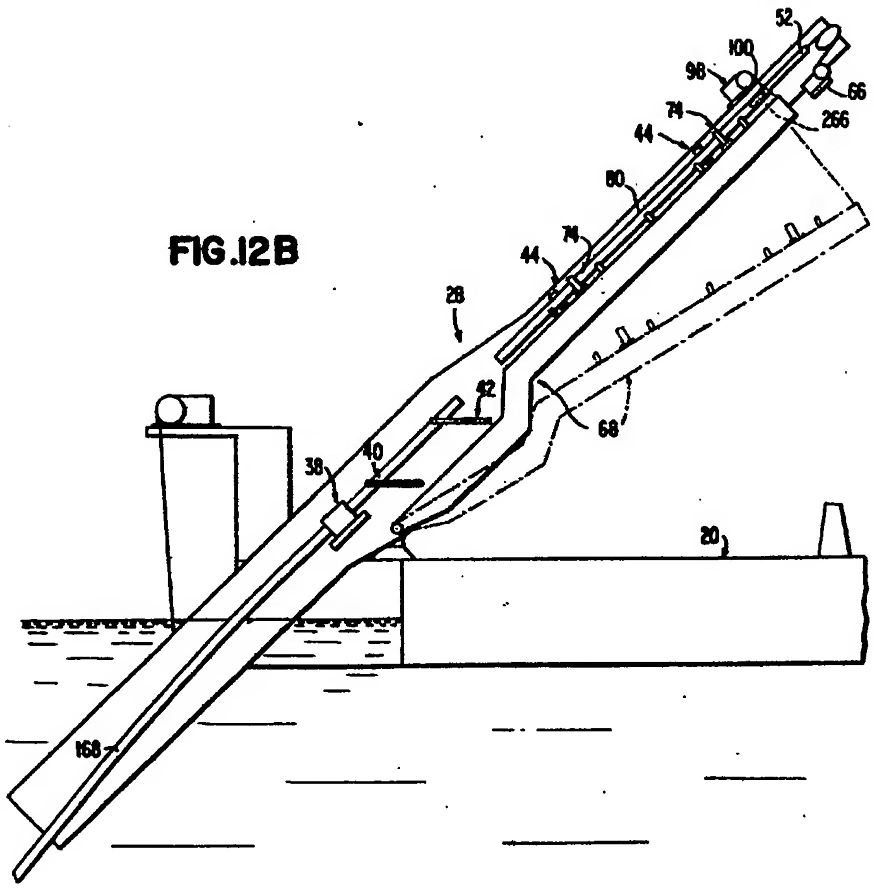


FIG.11

FIG.12B



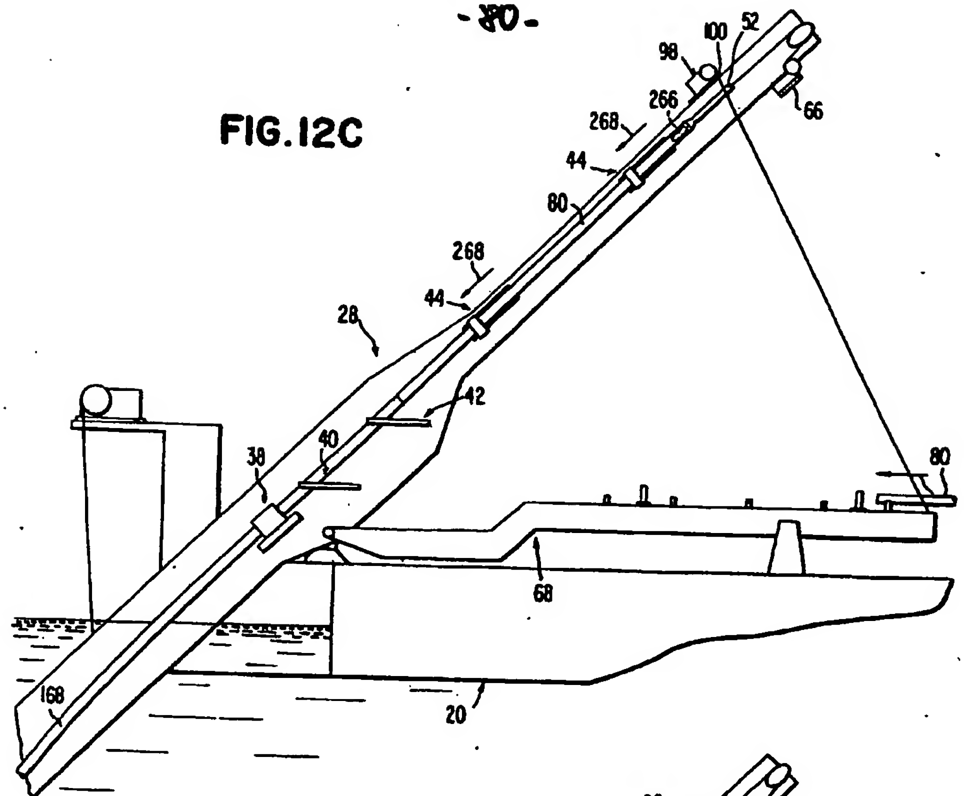


FIG.12C

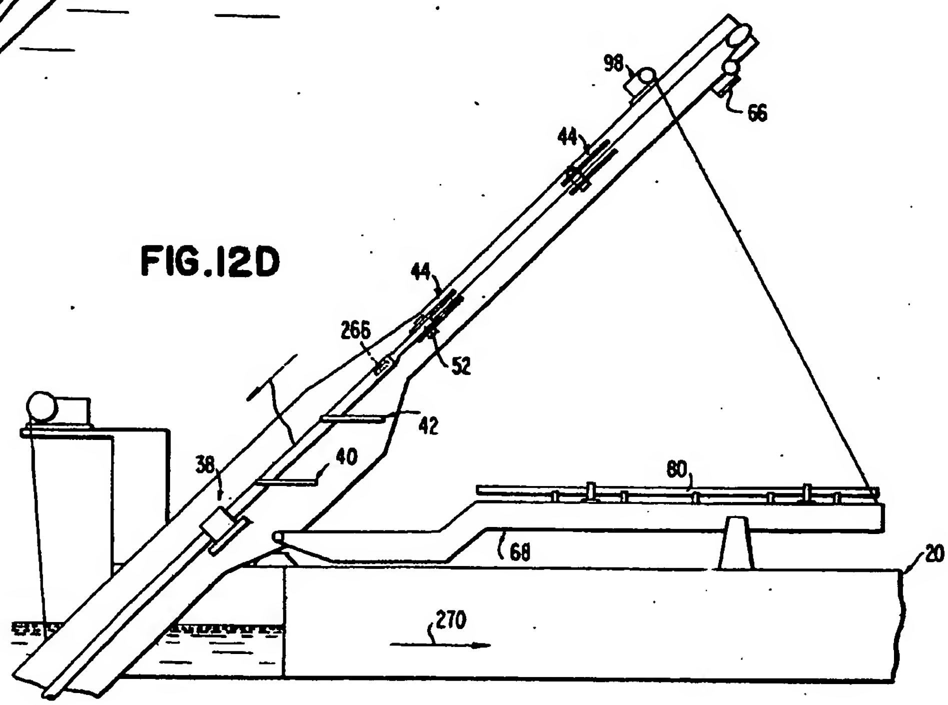


FIG.12D